

CLAIMS:

1. Integrated circuitry comprising a capacitor comprising a first capacitor electrode, a second capacitor electrode and a high K capacitor dielectric region received therebetween; the high K capacitor dielectric region comprising a high K substantially amorphous material layer and a high K substantially crystalline material layer.

2. The integrated circuitry of claim 1 wherein the high K substantially amorphous material and the high K substantially crystalline material constitute the same chemical composition.

3. The integrated circuitry of claim 1 wherein the high K substantially amorphous material and the high K substantially crystalline material constitute different chemical compositions.

4. The integrated circuitry of claim 1 wherein at least one of the first and second electrodes comprises elemental metal, metal alloy, conductive metal oxides, or mixtures thereof.

5. The integrated circuitry of claim 1 wherein at least one of the high K substantially amorphous material layer and the high K substantially crystalline material layer contacts at least one of the first capacitor electrode and the second capacitor electrode.

1 6. The integrated circuitry of claim 1 wherein the high K
2 substantially amorphous material layer contacts at least one of the first
3 capacitor electrode and the second capacitor electrode.

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5 7. The integrated circuitry of claim 6 wherein the high K
6 substantially amorphous material layer contacts only one of the first capacitor
7 electrode and the second capacitor electrode.

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9 8. The integrated circuitry of claim 1 wherein the high K
10 substantially amorphous material layer contacts one of the first and second
11 capacitor electrodes and the high K substantially crystalline material layer
12 contacts the other of the first and second capacitor electrodes.

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14 9. The integrated circuitry of claim 1 wherein the high K capacitor
15 dielectric region is the only capacitor dielectric region received between the
16 first and second capacitor electrodes, and consists essentially of the high K
17 substantially amorphous material layer and the high K substantially crystalline
18 material layer.

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20 10. The integrated circuitry of claim 1 wherein the high K
21 substantially amorphous material layer is at least 98% amorphous, and the
22 high K substantially crystalline material layer is at least 98% crystalline.

1 11. The integrated circuitry of claim 1 comprising a semiconductor
2 substrate, the capacitor being received at least partially over the semiconductor
3 substrate, the high K substantially crystalline material layer being received
4 between the semiconductor substrate and the high K substantially amorphous
5 material layer.

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7 12. The integrated circuitry of claim 11 wherein the semiconductor
8 substrate comprises bulk monocrystalline silicon.

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10 13. The integrated circuitry of claim 11 wherein at least one of the
11 high K substantially amorphous material layer and the high K substantially
12 crystalline material layer contacts at least one of the first capacitor electrode
13 and the second capacitor electrode.

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15 14. The integrated circuitry of claim 11 wherein the high K
16 substantially amorphous material layer contacts at least one of the first
17 capacitor electrode and the second capacitor electrode.

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19 15. The integrated circuitry of claim 1 comprising a semiconductor
20 substrate, the capacitor being received at least partially over the semiconductor
21 substrate, the high K substantially amorphous material layer being received
22 between the semiconductor substrate and the high K substantially crystalline
23 material layer.
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cont.

16. The integrated circuitry of claim 15 wherein the semiconductor substrate comprising bulk monocrystalline silicon.

17 Integrated circuitry comprising a capacitor comprising a first capacitor electrode, a second capacitor electrode and a Ta_2O_5 comprising capacitor dielectric region received therebetween; the Ta_2O_5 comprising region comprising a substantially amorphous Ta_2O_5 comprising layer and a substantially crystalline Ta_2O_5 comprising layer.

18. The integrated circuitry of claim 17 wherein at least one of the substantially amorphous Ta_2O_5 comprising layer and the substantially crystalline Ta_2O_5 comprising layer contacts at least one of the first capacitor electrode and the second capacitor electrode.

19. The integrated circuitry of claim 17 wherein the substantially amorphous Ta_2O_5 comprising layer contacts at least one of the first capacitor electrode and the second capacitor electrode.

20. The integrated circuitry of claim 19 wherein the substantially amorphous Ta_2O_5 comprising layer contacts only one of the first capacitor electrode and the second capacitor electrode.

1 21. The integrated circuitry of claim 17 wherein the substantially
2 amorphous Ta_2O_5 comprising layer contacts one of the first and second
3 capacitor electrodes and the substantially crystalline Ta_2O_5 comprising layer
4 contacts the other of the first and second capacitor electrodes.

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6 22. The integrated circuitry of claim 17 wherein the Ta_2O_5
7 comprising region is the only capacitor dielectric region received between the
8 first and second capacitor electrodes, and consists essentially of the
9 substantially amorphous Ta_2O_5 comprising layer and the substantially crystalline
10 Ta_2O_5 comprising layer.

11
12 23. A capacitor forming method comprising:

13 forming a first capacitor electrode layer over a substrate;

14 forming a high K capacitor dielectric region over the first capacitor
15 electrode layer, the high K capacitor dielectric region comprising a high K
16 substantially crystalline material layer and a high K substantially amorphous
17 material layer; and

18 forming a second capacitor electrode layer over the high K capacitor
19 dielectric region.

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21 24. The method of claim 23 comprising forming the high K
22 substantially amorphous material and the high K substantially crystalline
23 material to constitute the same chemical composition.
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1 25. The method of claim 24 wherein the chemical composition
2 comprises Ta_2O_5 .

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4 26. The method of claim 23 comprising forming the high K
5 substantially amorphous material and the high K substantially crystalline
6 material to constitute different chemical compositions.

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8 27. The method of claim 23 wherein at least one of the high K
9 substantially amorphous material layer and the high K substantially crystalline
10 material layer contacts at least one of the first capacitor electrode layer and
11 the second capacitor electrode layer.

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13 28. The method of claim 23 wherein the high K substantially
14 amorphous material layer contacts at least one of the first capacitor electrode
15 layer and the second capacitor electrode layer.

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17 29. The method of claim 28 wherein the high K substantially
18 amorphous material layer contacts only one of the first capacitor electrode
19 layer and the second capacitor electrode layer.

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21 30. The method of claim 23 wherein the high K substantially
22 amorphous material layer contacts one of the first and second capacitor
23 electrode layers and the high K substantially crystalline material layer contacts
24 the other of the first and second capacitor electrode layers.

1 31 The method of claim 23 wherein the high K capacitor dielectric
2 region is formed to be the only capacitor dielectric region received between
3 the first and second capacitor electrode layers, and consists essentially of the
4 high K substantially amorphous material layer and the high K substantially
5 crystalline material layer.

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7 32. The method of claim 23 wherein the high K substantially
8 amorphous material layer is formed to be at least 98% amorphous, and the
9 high K substantially crystalline material layer is formed to be at least 98%
10 crystalline.

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12 33. A capacitor forming method comprising:

13 forming a first capacitor electrode layer over a substrate;

14 depositing a substantially amorphous first high K capacitor dielectric
15 material layer over the first capacitor electrode layer;

16 converting the substantially amorphous high K first capacitor dielectric
17 material layer to be substantially crystalline;

18 after the converting, depositing a substantially amorphous second high K
19 capacitor dielectric material layer over the substantially crystalline first high K
20 capacitor dielectric material layer; and

21 forming a second capacitor electrode layer over the substantially
22 amorphous second high K capacitor dielectric material layer.

1 34. The method of claim 33 further comprising after the converting
2 and before forming the second capacitor electrode layer, oxidize annealing the
3 second high K capacitor dielectric material layer in an oxygen containing
4 atmosphere at a temperature of no greater than about 600°C and effective to
5 maintain the second high K capacitor dielectric material layer substantially
6 amorphous.

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8 35. The method of claim 33 further comprising after the converting
9 and before forming the second capacitor electrode layer, oxidize annealing the
10 second high K capacitor dielectric material layer in an oxygen containing
11 atmosphere at a temperature of from about 300°C to about 550°C and
12 effective to maintain the second high K capacitor dielectric material layer
13 substantially amorphous.

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15 36. The method of claim 33 wherein the converting occurs in an
16 atmosphere which is substantially void oxygen.

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18 37. The method of claim 33 wherein the first and second dielectric
19 material layers are formed to constitute the same chemical composition.

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21 38. The method of claim 37 wherein the chemical composition
22 comprises Ta₂O₅.

1 39. The method of claim 33 wherein the first and second dielectric
2 material layers are formed to constitute different chemical compositions.

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4 40. The method of claim 33 wherein the second capacitor electrode
5 layer is formed to contact the substantially amorphous second high K capacitor
6 dielectric material layer.

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8 41. The method of claim 33 wherein the first high K capacitor
9 dielectric material layer is formed to contact the first capacitor electrode layer.

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11 42. The method of claim 33 wherein the first high K capacitor
12 dielectric material layer is formed to contact the first capacitor electrode layer,
13 and the second capacitor electrode layer is formed to contact the substantially
14 amorphous second high K capacitor dielectric material layer.

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16 43. The method of claim 33 wherein the first high K capacitor
17 dielectric material layer is formed to contact the first capacitor electrode layer,
18 the second high K capacitor dielectric material layer is formed to contact the
19 first high K capacitor dielectric material layer, and the second capacitor
20 electrode layer is formed to contact the second high K capacitor dielectric
21 material layer.

1 44. A capacitor forming method comprising:
2 forming a first capacitor electrode layer over a substrate;
3 depositing a substantially amorphous first high K capacitor dielectric
4 material layer over the first capacitor electrode layer;
5 oxidize annealing the first high K capacitor dielectric material layer in
6 an oxygen containing atmosphere at a temperature of no greater than about
7 600°C;
8 after the oxidize annealing of the first high K capacitor dielectric
9 material layer, converting the substantially amorphous high K first capacitor
10 dielectric material layer to be substantially crystalline;
11 after the converting, depositing a substantially amorphous second high K
12 capacitor dielectric material layer over the substantially crystalline first high
13 K capacitor dielectric material layer;
14 oxidize annealing the second high K capacitor dielectric material layer
15 in an oxygen containing atmosphere at a temperature of no greater than about
16 600°C and effective to maintain the second high K capacitor dielectric
17 material layer substantially amorphous; and
18 forming a second capacitor electrode layer over the substantially
19 amorphous second high K capacitor dielectric material layer.
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21 45. The method of claim 44 further wherein the first and second
22 oxidize annealings comprise annealing in an oxygen containing atmosphere at
23 a temperature of no greater than about 600°C.
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1 46. The method of claim 44 wherein the converting occurs in an
2 atmosphere which is substantially void oxygen.

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4 47. The method of claim 44 wherein the first and second dielectric
5 material layers are formed to constitute the same chemical composition.

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7 48. The method of claim 47 wherein the chemical composition
8 comprises Ta_2O_5 .

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10 49. The method of claim 44 wherein the first and second dielectric
11 material layers are formed to constitute different chemical compositions.
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1 50. A capacitor forming method comprising:
2 forming a first capacitor electrode layer over a substrate;
3 depositing a substantially amorphous first high K capacitor dielectric
4 material layer over the first capacitor electrode layer;
5 converting the substantially amorphous high K first capacitor dielectric
6 material layer to be substantially crystalline;
7 after the converting of the substantially amorphous high K first
8 capacitor dielectric material layer, oxidize annealing the first high K capacitor
9 dielectric material layer in an oxygen containing atmosphere at a temperature
10 of no greater than about 600°C;
11 after the oxidize annealing of the first high K capacitor dielectric
12 material layer, depositing a substantially amorphous second high K capacitor
13 dielectric material layer over the substantially crystalline first high K capacitor
14 dielectric material layer;
15 oxidize annealing the second high K capacitor dielectric material layer
16 in an oxygen containing atmosphere at a temperature of no greater than about
17 600°C and effective to maintain the second high K capacitor dielectric
18 material layer substantially amorphous; and
19 forming a second capacitor electrode layer over the substantially
20 amorphous second high K capacitor dielectric material layer.

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22 51. The method of claim 50 further wherein the first and second
23 oxidize annealings comprise annealing in an oxygen containing atmosphere at
24 a temperature of no greater than about 600°C.

1 52. The method of claim 50 wherein the converting occurs in an
2 atmosphere which is substantially void oxygen.

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4 53. The method of claim 50 wherein the first and second dielectric
5 material layers are formed to constitute the same chemical composition.

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7 54. The method of claim 53 wherein the chemical composition
8 comprises Ta_2O_5 .

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10 55. The method of claim 50 wherein the first and second dielectric
11 material layers are formed to constitute different chemical compositions.

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13 add
14 D2
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add
E2

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17 add
18 F5
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